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Increased default-mode network connectivity in cancer patients with chronic pain

Akiko Mori, Yumie Ono, Wen-Ying Lin

***Abstract*— We investigated the strength of resting-state EEG functional connectivity of the default mode network (DMN) between healthy participants and cancer patients with chronic pain to explore the effect of chronic cancer pain on the intrinsic cortical network. Cancer patients showed augmented functional connectivity between the anterior-to-posterior DMN regions relative to healthy participants in alpha 1 and beta 2 bands. These results support the disruptions of the DMN that were observed in patients with other types of chronic pain such as back pain and fibromyalgia.**

***Clinical Relevance*— Revealing the altered network structure of the resting-state brain network may contribute to understanding the psychological and/or cognitive decline hypothesized in cancer patients suffering from chronic pain.**

I. INTRODUCTION

The number of cancer cases is increasing and chronic cancer pain impacts patient's quality of life. Depression and anxiety are common mental health problems in cancer patients with chronic pain. The long-term pain is considered to disrupt the intrinsic cortical network, especially the default mode network (DMN), to develop the cognitive and behavioral impairments accompanying chronic pain [1]. Although the altered structure of the DMN is reported in patients with various chronic pain origins such as back pain [1] and fibromyalgia [2], there has been little investigation on the DMN activity of the patients with chronic cancer pain. This preliminary study aimed to investigate the difference in DMN activity between such patients and healthy participants.

II. METHODS

Two cancer patients with left abdominal chronic pain (2 male, age: 50 and 55 years, both under weak opioid treatment) participated in this study. Fourteen-channel EEG was recorded for resting state with eyes open. Previously published EEG data [3] of 21 healthy young adults were used as control. We removed blink and muscle artifacts from the EEG data using independent component analysis implemented in EEGLAB. Functional connectivity was assessed with lagged coherence implemented in sLORETA between pairs of 6 regions of interests (ROIs) for DMN: the medial prefrontal cortex (mPFC), anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), retrosplenial cortex (Rsp), inferior parietal lobule (IPL), and lateral temporal cortex (LTC). The functional connectivity was assessed within 7 frequency bands of the delta, theta, alpha 1, alpha 2, beta 1, beta 2, and beta 3 ranges that are defined in sLORETA. We calculated the z score of the lagged coherence values of each patient relative to those of healthy participants. The z scores whose absolute value exceeds 1.96 (equivalent to $p < 0.05$) are considered statistically significant.

Akiko Mori is with Graduate School of Science and Technology, Meiji University, Kanagawa, Japan. (e-mail: clarinet.aki.96@gmail.com) Yumie Ono is with School of Science and Technology, Meiji University, Kanagawa, Japan. Wen-Ying Lin is with National Taiwan University Cancer Center Department of Anesthesiology, National Taiwan University Hospital, Taiwan.

III. RESULTS

Figure 1 illustrates the functional connectivity networks within DMN regions that showed a statistically significant increase in cancer patients. The nodes and edges show 6 ROIs of the DMN and anatomical connection in which both patients exhibited increased connectivity, respectively. Increased DMN strength were found in alpha 1 and beta 2 frequency ranges, mainly between anterior (mPFC, ACC) and posterior (PCC, Rsp, IPL) DMN regions. There were no edges showing decreased functional connectivity in patients.

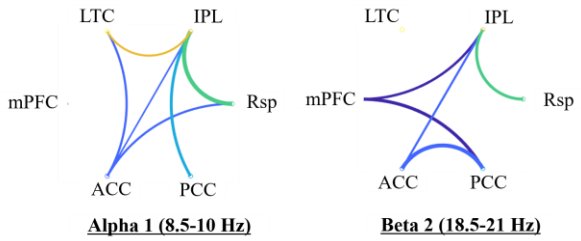

Figure 1. Increased functional connectivity within the DMN regions in patients with chronic cancer pain relative to healthy controls. The thickness of the edge indicate the strength of averaged z score.

IV. DISCUSSION & CONCLUSION

We found that functional connectivity in the DMN was increased in chronic cancer pain patients as in chronic back pain or fibromyalgia patients [1,2]. Regardless of the primary diseases, chronic pain might change the activity of the DMN as a potential cause of mental health problem.

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